

Two new species of the *Canthocamptus mirabilis* group (Copepoda: Harpacticoida: Canthocamptidae) from South Korea

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Abstract.—Two new harpacticoid species belonging to *Canthocamptus mirabilis* species group, *C. odaeensis* and *C. incurvisetosus*, are described from South Korea, with an evaluation of the variability of several characters. Both species are assumed to be closely related in sharing the apomorphic characters of the triangular hyaline membrane on the anal operculum and the male-type caudal ramus in females. The occurrence of the *C. mirabilis* group in South Korea is also briefly commented. *Canthocamptus incurvisetosus* is most widely distributed and frequently occurs in mountain waters of South Korea, while *C. odaeensis* is a geographically isolated species. They co-occurred at only one location, where the reproductive isolation of these species is reinforced by character displacements, especially of the female caudal ramus and the ornamentation of the leg 5 exopod.

The *Canthocamptus mirabilis* group, first identified as “*Attheyella*-like *Canthocamptus*” by Ito & Takashio (1980), was recognized in a series of faunistic studies on mountain harpacticoids in Japan (Ishida 1987, 1989, 1990, 1991; Kikuchi & Ishida 1988, 1994). It comprises several closely related species, occurring with great abundance and frequency in the various mountain water bodies of the Far East. Six species are currently known in this group: *C. mirabilis* Štěrba, 1968 from China; *C. morimotoi* Miura, 1969 from South Korea; and *C. prominulus* Kikuchi, 1993, *C. semicirculus* Kikuchi, 1993, *C. resupinatus* Ishida, 1993, and *C. tomikoeae* Ishida, 1993 from Japan.

In Korea, except for the record of *C. morimotoi* (Miura 1969, Chang 1998), the *mirabilis* group has not been studied in spite of its great abundance and frequent occurrence in the various mountain water bodies. We have fully re-examined the specimens belonging to the *C. mirabilis* group which were gathered from 120 lo-

calities in South Korea since 1986 by the senior author. We confirmed that they comprise five species: *C. semicirculus* Kikuchi; an unrecorded species, to be treated later in another paper, closely resembling *C. mirabilis* Štěrba from China; *C. morimotoi* Miura; and the two new species described here.

Collections were made with a dipnet with no. 10 mesh. All the specimens were dissected, drawn, and measured in lactophenol on a Cobb's hole slide. Figures were drawn with the aid of a camera lucida. Type material has been deposited in the U.S. National Museum of Natural History, Smithsonian Institution (USNM) and the Natural History Museum of Ewha Womans University, Seoul (EWNMH).

The caudal ramus, or furca, of species of the *C. mirabilis* group commonly show clear sexual dimorphism, but females in some populations have a furca similar to the males, a reversal of this secondary sexual character state (Ito & Takashio 1980, Ishida 1991). The normal furca and the male-type furca of females are abbreviated in the text

and figure legends to Fn and Fr, respectively. Abbreviations of enp 1–3 or exp 1–3 are used in the description to denote the first to third endopodal or exopodal segment of each leg.

Canthocamptus odaeensis, new species

Figs. 1–4

Material examined.—Twelve ♀♀, 7 ♂♂, foothill spring at Kangnung City (37°45' 59"N, 128°52'27"E), 23 Sep 1993, leg. C. Y. Chang, including: Holotype ♀ (USNM 310129), allotype ♂ (USNM 310130), and paratypes (3 ♀♀, USNM 310131; 8 ♀♀ & 6 ♂♂, EWNMH 60262).

Additional material.—Seven ♀♀, 3 ♂♂, streamlet at Mt. Odae, 2 Oct 1992, C. Y. Chang; 1 ♀, 3 ♂♂, spring at Kujeol-ri, Cheongseon, 23 Sep 1993, C. Y. Chang; 5 ♀♀, 3 ♂♂, Chodang Cave, Samcheok, 12 May 1995, H. S. Rho; 5 ♀♀, 2 ♂♂, same as type locality, 21 Jul 1995, C. Y. Chang; 3 ♀♀, 1 ♂, streamlet near Woljungsa Temple, Mt. Odae, 28 Jul 1999, J. M. Lee & Y. H. Song; 5 ♀♀, 6 ♂♂, Mureung Valley, Mt. Duta, 9 Oct 1999, J. M. Lee & Y. H. Song; 3 ♀♀, 2 ♂♂, trickle near Hwansun Cave, Samcheok, 9 Oct 1999, J. M. Lee & Y. H. Song; 2 ♀♀, 2 ♂♂, Gongsujeon Valley, Yangyang, 6 Oct 2000, C. Y. Chang. All additional material is retained in the research collection of C. Y. Chang, except 5 ♀♀ and 3 ♂♂ from Mt. Odae (2 Oct 1992) in the collection of T. Ishida.

Female.—Body (Fig. 1A) length range 0.64–0.69 mm (0.66 ± 0.04 mm, $N = 8$), excluding rostrum and furcal setae; broadest at posterior margin of cephalothorax, tapering posteriorly. Prosoma elliptical. Cephalothorax somewhat protruding anteriorly, slightly longer than succeeding 3 thoracic somites combined. Rostrum not prominent, directed anteroventrally, not distinct at base. Dorsal and lateral surfaces of thoracic somites with few sensilla; posterior part of cephalothorax bearing narrow hyaline membrane with 10–12 longitudinal folds along margin, each bearing 1 sensil-

lum at its tip. Genital double somite moderately expanded laterally and slightly broadened posteriorly, 1.25 times wider than long, subdivided by pair of lateral sutures, each suture with pair of sensilla near its dorso-medial end. Genital area T-shaped, flanks rather short. Each abdominal somite furnished with 1 row of spinules along laterodistal corner, and hyaline fringes with crenate posterior margins (Fig. 1B). Disto-medial corner of ventral side of anal somite bearing 3–4 sharp spinules (Fig. 1C), relatively undeveloped in comparison with those of *C. morimotoi* (cf. Chang 1998) or *C. mirabilis* sensu Ito & Takashio. Anal operculum convex; hyaline membrane (Fig. 1C) forming obtuse-angled triangle, its tip slightly passing dorsal seta of caudal ramus in lateral view (Fig. 1B).

Fr (Fig. 1C) shaped as an inverted bottle; about 1.5 times as long as wide, armed with 1 crescent row of slender spinules along medial surface; outer caudal seta ornamented with 2–3 pairs of sharp secondary spinules, directed outward and situated from proximal 1/5 to 1/3 of the seta (Figs. 1B, C); terminal seta stout, slightly bent and constricted near base; inner caudal seta bare. Fn somewhat suboval (Fig. 1D), about 1.3 times as long as wide. About 6 spinules arranged obliquely at laterodistal corner of dorsal surface. Outer terminal seta rather straight, not bent, with 3 secondary spinules on inner margin and 4–5 acute spinules on outer margin.

Antennule (Fig. 2A) of 8 segments, bearing 1 aesthetasc on anterodistal margin of fourth article, its tip not reaching distal end of antennule. Exopod of antenna (Fig. 2B) distinctly 2-segmented; first segment markedly slender, bearing 1 plumose seta on inner distal edge with 1 spinule on laterodistal margin; second segment bearing 2+1 plumose setae. Labrum subtriangular, with blunt hirsute tip, furnished with 4 subdistal spinules. Mandible, maxillule, maxilla, and maxilliped (Fig. 2C–F) with typical characteristics of genus *Canthocamptus* and showing no significant discrepancy from re-

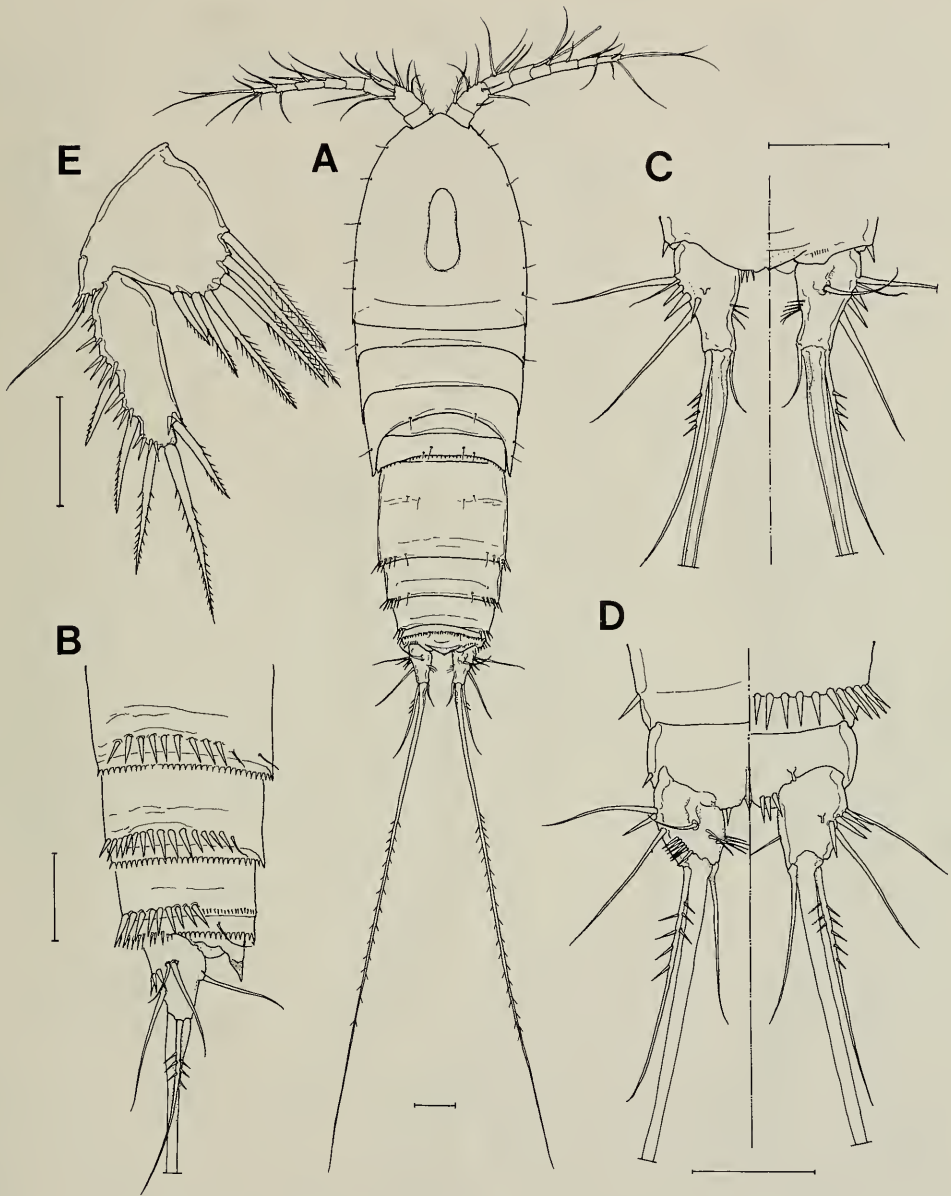


Fig. 1. *Canthocamptus odaensis*, Female. A, Habitus (dorsal); B, Urosome (lateral); C, Anal somite and caudal ramus, showing both ventral (left) and dorsal (right) sides (Fr type); D, Anal somite and caudal ramus (Fn type); E, Female leg 5. Scale bars = 0.05 mm.

lated members of *mirabilis* group (cf. Ito & Takashio 1980, Chang 1998).

Exopod and endopod of legs 1–4 each consisting of 3 segments, except endopod of leg 4 with 2 segments. Leg 1 (Fig. 2G) enp 1 as long as exopod, with 1 plumose seta on distal 1/5 of inner margin; enp 2

with 1 plumose seta on inner distal corner and 3 sharp spinules on outer edge; enp 3 slender, bearing 2 geniculate spines and 1 plumose seta. Exp 1 longer than next two segments; exp 2 with 1 inner seta and 1 outer spine; exp 3 bearing 2 outer spines and 2 geniculate setae. Distal edge of inter-

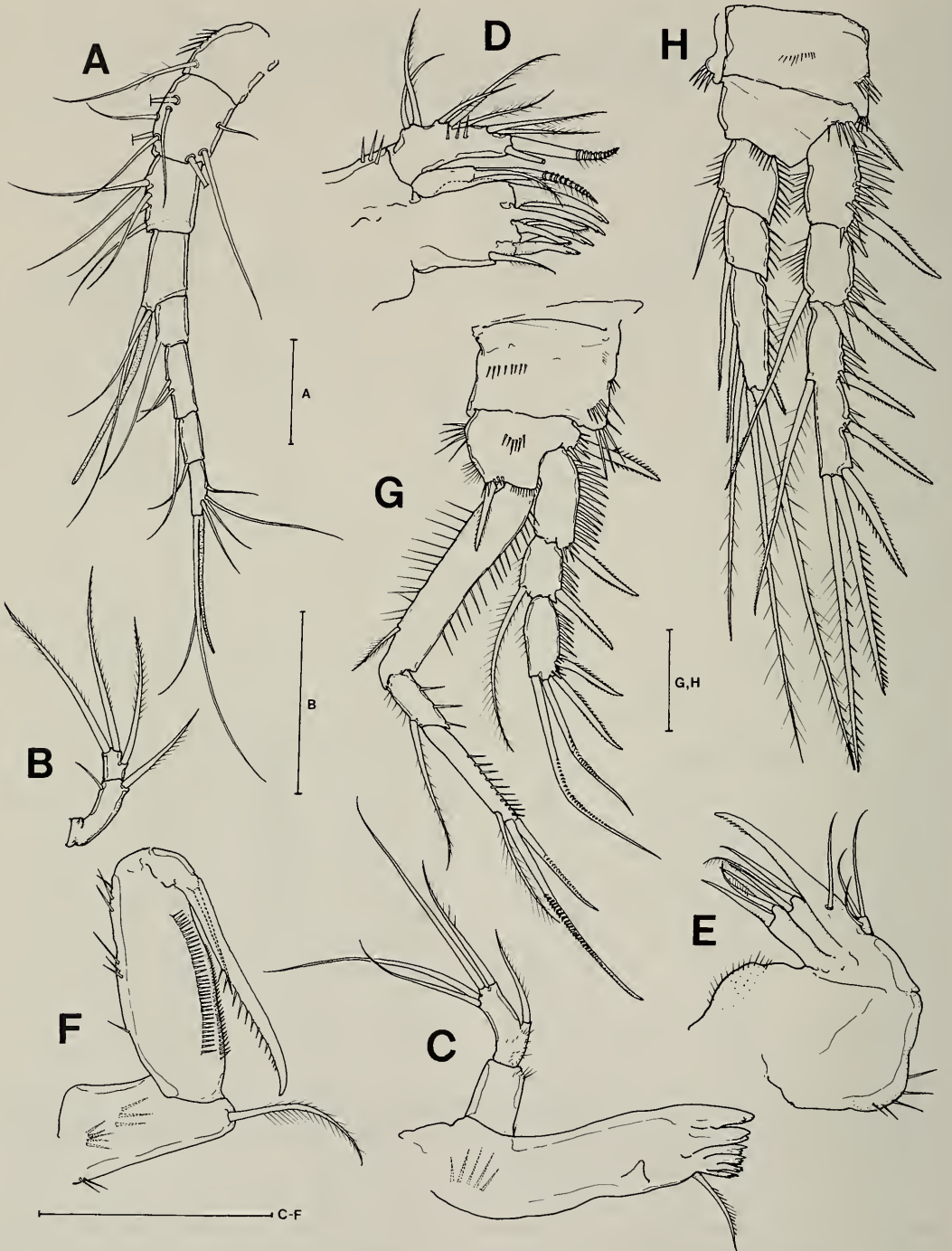


Fig. 2. *Canthocamptus odaeensis*, Female. A, Antennule; B, Exopod of antenna; C, Mandible; D, Maxillule; E, Maxilla; F, Maxilliped; G, Leg 1; H, Leg 2. Scale bars = 0.05 mm.

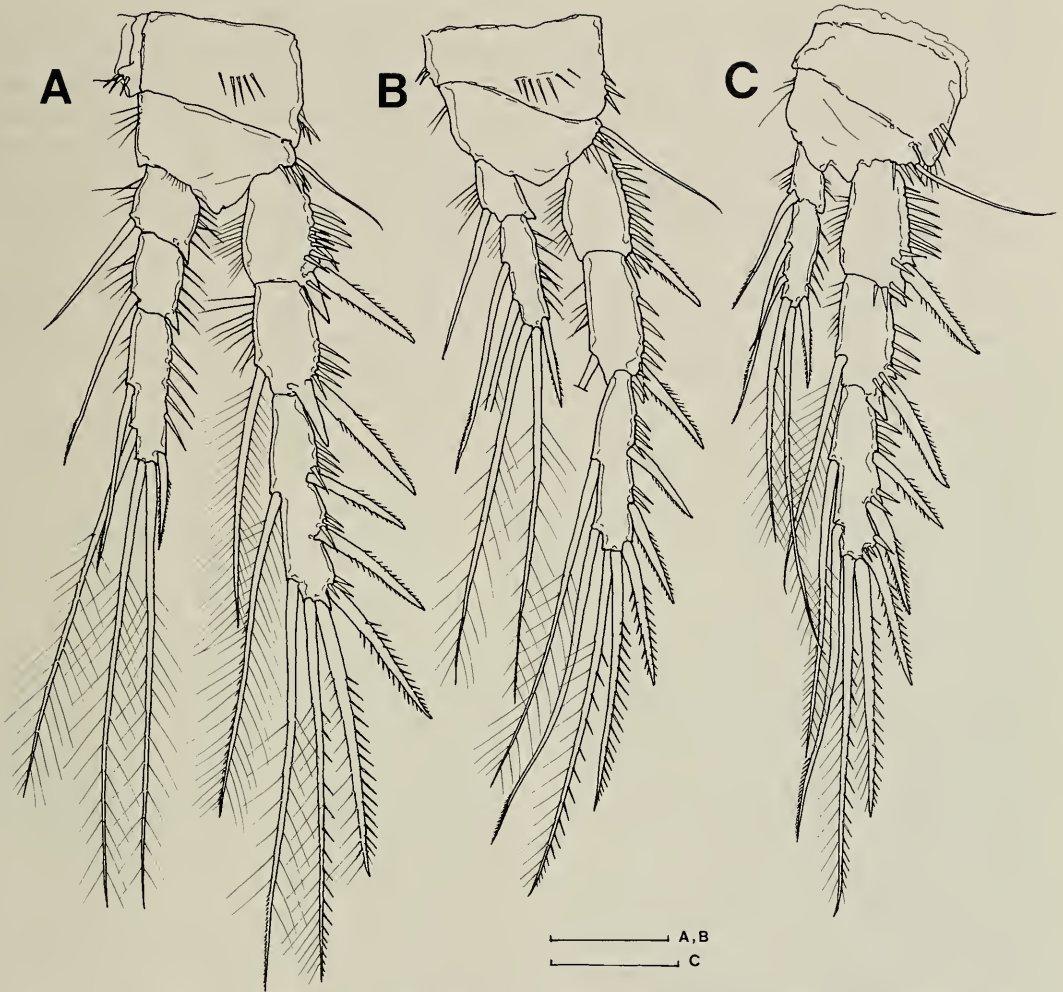


Fig. 3. *Canthocamptus odaensis*. A, Female leg 3; B, Female leg 4; C, Male leg 4. Scale bars = 0.05 mm.

coxal sclerites of legs 2–4 with several spinules. Ornamentation of legs 2–4 as follows (in armature formula, Roman numerals indicate spines and Arabic numerals represent setae):

Leg 2: basis I-0; exp I-0; I-1; III, 2, 1
 enp 0-1; 0-1; I, 2, 2

Leg 3: basis 1-0; exp I-0; I-1; III, 2, 2
 enp 0-1; 0-1; I, 2, 2

Leg 4: basis 1-0; exp I-0; I-1; III, 2, 2
 enp 0-1; I, 2, 2

Distal end of leg 5 baseoendopod (Fig.

1E) not reaching middle of exopod; baseoendopod not confluent at its base, connected by intercoxal sclerite; bearing 6 spiniform setae, of which outermost two setae shortest and next innermost seta longest. Exopod rather oblong, slightly tapering distally, about 2.7 times as long as broad; inner margin slightly swollen; armed with 5 setae, distalmost seta of which slightly longer than exopod; 2 spinules usually present on distomedial corner on ventral side of exopod near base of inner seta.

Male.—Body (Fig. 4A) length from 0.63–0.68 mm (0.64 ± 0.04 mm, $N = 6$). Overall appearance like female, except with

more slender caudal ramus. Hyaline membrane on anal operculum (Fig. 4B) triangular with convex margin, its tip reaching level of dorsal seta. Leg 2 (Fig. 4C), enp 1 with 1 inner seta; enp 2 bearing 3 inner, 2 long terminal setae, with outer spinules; 2 inner setae of enp 2 and inner seta of exp 3 modified with pectinate tip. Leg 3 (Fig. 4D), enp 2 armed with 1 acute spiniform seta and 1 process (apophysis) with terminal barbs, not extending beyond exp 3; enp 3 elongate, slightly longer than combined lengths of two proximal segments, tapering distally, ending with 2 plumose setae; exp 2 armed with stout spiniform process on outer distal corner, its tip usually not reaching or rarely reaching slightly beyond distal margin of exp 3; exp 3 with 2 inner setae, distal one bent with pectinate tip. Leg 4 (Fig. 3C) nearly same shape as that of female, including outer terminal seta on exp 3 armed with more than 18 spinules on outer margin of seta; distal inner seta of exp 3 modified with pectinate tip. Baseoendopodal lobe of leg 5 (Fig. 4E) triangular, not reaching middle of exopod; bearing 2 spiniform setae, inner seta about 1.3 times longer than outer; inner margin bare. Exopod 2.1 times longer than broad, armed with 6 setae in total, consisting of 1 weak plumose seta at about middle of medial margin, 1 inner distal, 2 terminal, and 2 outer spiniform setae. Leg 6 (Fig. 4B) represented by small plate bearing 1 spine and 2 slender setae.

Variability.—Females with normal-type caudal ramus (Fn) were rarely observed (fewer than 1% of all specimens examined). No significant variation was observed in the caudal ramus among the specimens examined, except that about 8% of Fr lacked the medial spinules (while all males examined had the spinules). The spiniform process on the male leg 3 exp 2 usually did not reach or reached only slightly beyond the tip of the leg 3 exp 3. Most females (78% of specimens examined) had two spinules on the inner distal edge of the ventral surface of the leg 5 exopod.

The ornamentation of the outer terminal caudal seta was characteristic and consistent in all the specimens examined, as was the unmodified outer terminal seta (armed with about 18 or more secondary spinules on outer margin of the seta) on the male leg 4 exp 3. No particular difference was detected in the major ornamentation of legs 2–4.

Etymology.—The specific name is taken from Mt. Odae, because the distribution of this new species is confined to Mt. Odae and the surrounding area.

Remarks.—Affinities with related species are discussed together with the next species.

Canthocamptus incurvisetosus, new
species
Figs. 5–6

Material examined.—Eleven ♀♀, 5 ♂♂, mountain streamlet in Seonamsa Valley, Mt. Jogye (34°59'26"N, 127°19'53"E), 13 Jan 2000, leg. C. Y. Chang, J. M. Lee & Y. H. Song, including: holotype ♀ (USNM 310132), allotype ♂ (USNM 310133), and paratypes (3 ♀♀, USNM 310134; 7 ♀♀ & 4 ♂♂, EWNMH 60261).

Additional material.—Eleven ♀♀, 9 ♂♂, spring, Ssangyesa Temple, Mt. Chiri, 21 Jan 1987, C. Y. Chang; 3 ♀♀, streamlet, Mt. Wolchul, 7 Feb 1987, C. Y. Chang; 9 ♀♀, 4 ♂♂, spring, Mt. Namdogyu, 8 Aug 1987, C. Y. Chang; 5 ♀♀, 4 ♂♂, trickle in Seonamsa Valley, Mt. Jogye, 31 Jan 1991, C. Y. Chang; 3 ♀♀, 2 ♂♂, Pongrae Fall, Ulung I., 3 Mar 1995, C. Y. Chang; 3 ♂♂, streamlet, Mt. Chiak, 27 Jun 1995, C. Y. Chang; 5 ♀♀, 4 ♂♂, streamlet, Mt. Sorak, 3 May 1998, S. M. Yoon; 4 ♀♀, 3 ♂♂, trickle in Naewonsa Valley, Mt. Chiri, 26 Oct 1999, C. Y. Chang & J. M. Lee; 10 ♀♀, 6 ♂♂, Mt. Seongju, Poryong, 20 Nov 1999, C. Y. Chang. All additional material is retained in the research collection of C. Y. Chang, except 3 ♀♀ and 2 ♂♂ from Mt. Chiri (21 Jan 1987) in the collection of T. Ishida.

Female.—Body length 0.69–0.73 mm

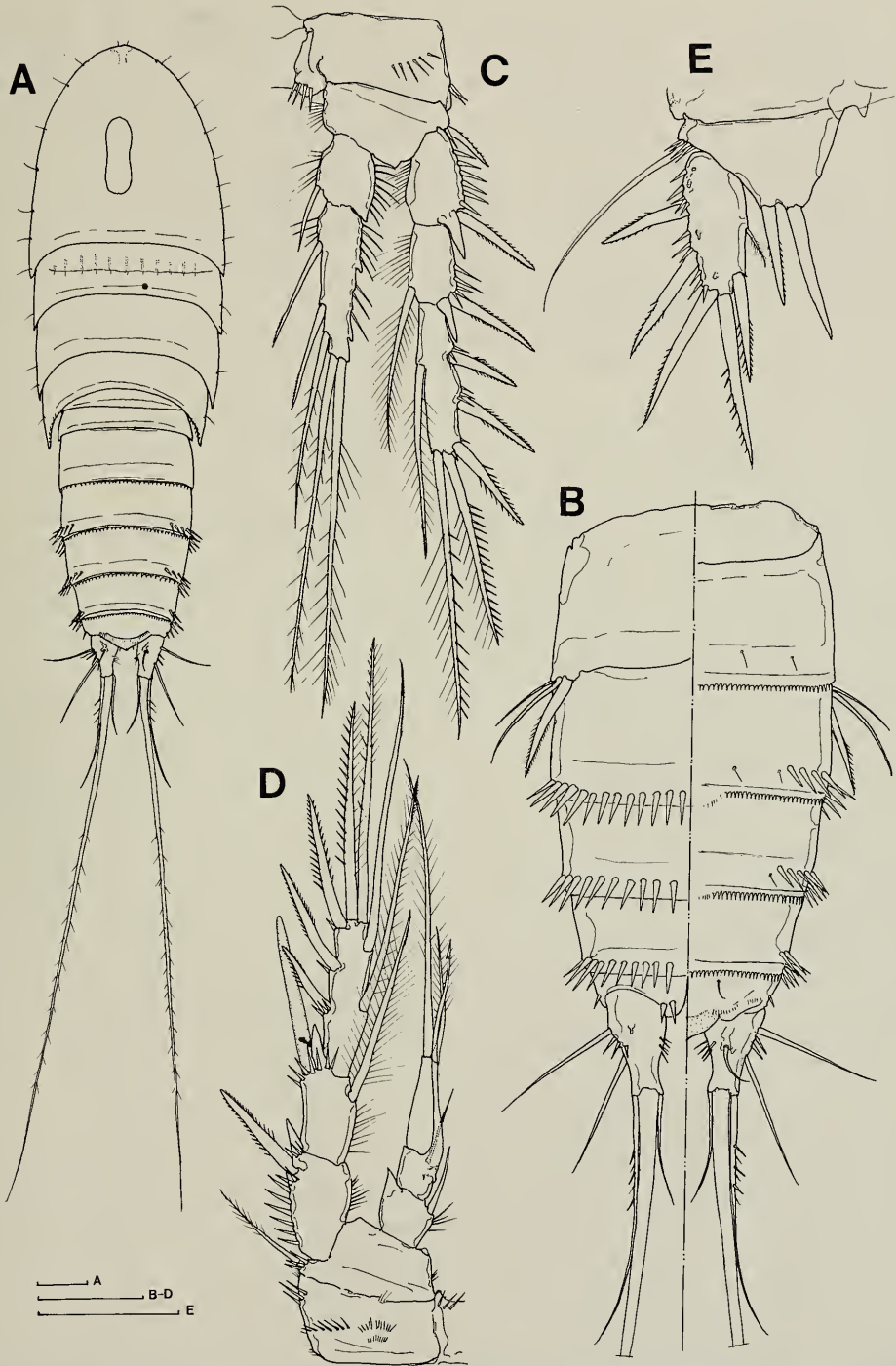


Fig. 4. *Canthocamptus odaensis*, Male. A, Habitus (dorsal); B, Urosome showing both ventral (left) and dorsal (right) sides; C, Leg 2; D, Leg 3; E, Leg 5. Scale bars = 0.05 mm.

(0.71 ± 0.02 mm, $N = 7$), excluding rostrum and caudal setae; overall appearance and mouthparts not showing significant differences from those of preceding species. Each abdominal somite bearing 1 row of spinules along laterodistal margin, and adorned with crenate hyaline frill (Fig. 5A). Posteromedial corner of ventral side of anal somite bearing 4–5 acute spinules. Anal operculum convex, furnished with hyaline membrane (Figs. 5B, C) forming obtuse-angled triangle with convex margin, but its tip projecting sharply.

Caudal ramus of normal type (Fig. 5B) ovoidal, about 1.76 times as long as wide, ornamented with crescent row of slender spinules along medial surface; laterodistal part of dorsal surface adorned with 6–9 spinules; dorsal keel over dorsal seta not prominent; outer terminal caudal seta twisted and curved inward, ornamented with 2–3 long, inward-directed secondary spinules on medial face of the seta; terminal seta slightly bent and constricted near base; inner caudal seta bare and strongly bent near its base. Fr (Fig. 5C) shaped as inverted bottle, about 1.5 times as long as wide, without spinules on outer distal part of dorsal surface; with or without crescent row of slender spinules along medial surface, this row sometimes present on only one ramus; other characters same as those of normal type ramus.

Segmentation and ornamentation of legs 1–4 exactly as those of preceding species. Leg 5 (Fig. 5D) exopod elongate, a little tapering distally, about 3.2 times as long as broad; inner margin slightly swollen; armed with 5 setae, of which inner distal seta always slightly shorter or as long as exopod; inner seta located near distomedial edge of exopod; spinules on distomedial corner of exopod usually absent, but sometimes 2–3 spinules present. Baseoendopod reaching about $\frac{1}{4}$ length of exopod; baseoendopod not confluent at its base, connected by intercoxal sclerite; bearing 6 spiniform setae, two outermost setae smallest and two innermost longest.

Male.—Body (Fig. 6A) length from 0.54–0.63 mm (0.59 ± 0.05 mm, $N = 5$). Hyaline membrane of anal operculum (Fig. 6B) triangular, its tip extending beyond level of dorsal setae of the caudal ramus. Distomedial corner of anal somite bearing 3–4 spinules, these relatively stronger than corresponding spinules of female. Caudal ramus (Fig. 6B) rather elongate, tapering posteriorly, about 1.76 times as long as wide, with no spinule row along medial surface; dorsal keel not prominent and dorsal surface smooth except for dorsal seta; outer terminal caudal seta normal, i.e., not twisted and not curved inward as in female, and ornamented with 2–3 outwardly directed secondary spinules; inner caudal seta unarmed. Leg 3 (Fig. 6D) exp 2 armed with stout spiniform process on outer distal corner, its tip extending far beyond distal end of exp 3. Leg 4 (Fig. 6E) exp 3 outer terminal seta with 3–4 sharp and strong spinules on outer margin. Other characters of legs 2–4 not showing significant discrepancies from preceding species. Baseoendopod of leg 5 (Fig. 5E) protruding, but not reaching $\frac{1}{3}$ of exopod; bearing 2 terminal spiniform setae, inner seta about 1.43 times longer than outer seta; inner margin bare. Exopod 2.4 times longer than broad, armed with 6 setae in total, these consisting of 1 weak plumose seta on inner middle, 1 inner distal, 2 terminal, and 2 outer spiniform setae. Leg 6 (Fig. 6F) a small plate bearing 1 stout spine and 2 slender setae; spine 1.4 times longer than next seta.

Variability.—Fn always possesses the spinule array on the medial surface of the caudal ramus, while 38% of Fr (male-type caudal ramus) were unarmed, as were more than 95% of the males. 18% of Fr had spinules on one caudal ramus but not on the other. The spinule arrangement on the outer distal corner was absent in Fr, and sometimes also absent in Fn; rarely individuals possessed both the different types of ornamentation. Usually (in more than 95% of cases) the spiniform process on the outer distal edge of the male leg 3 exp 2 much

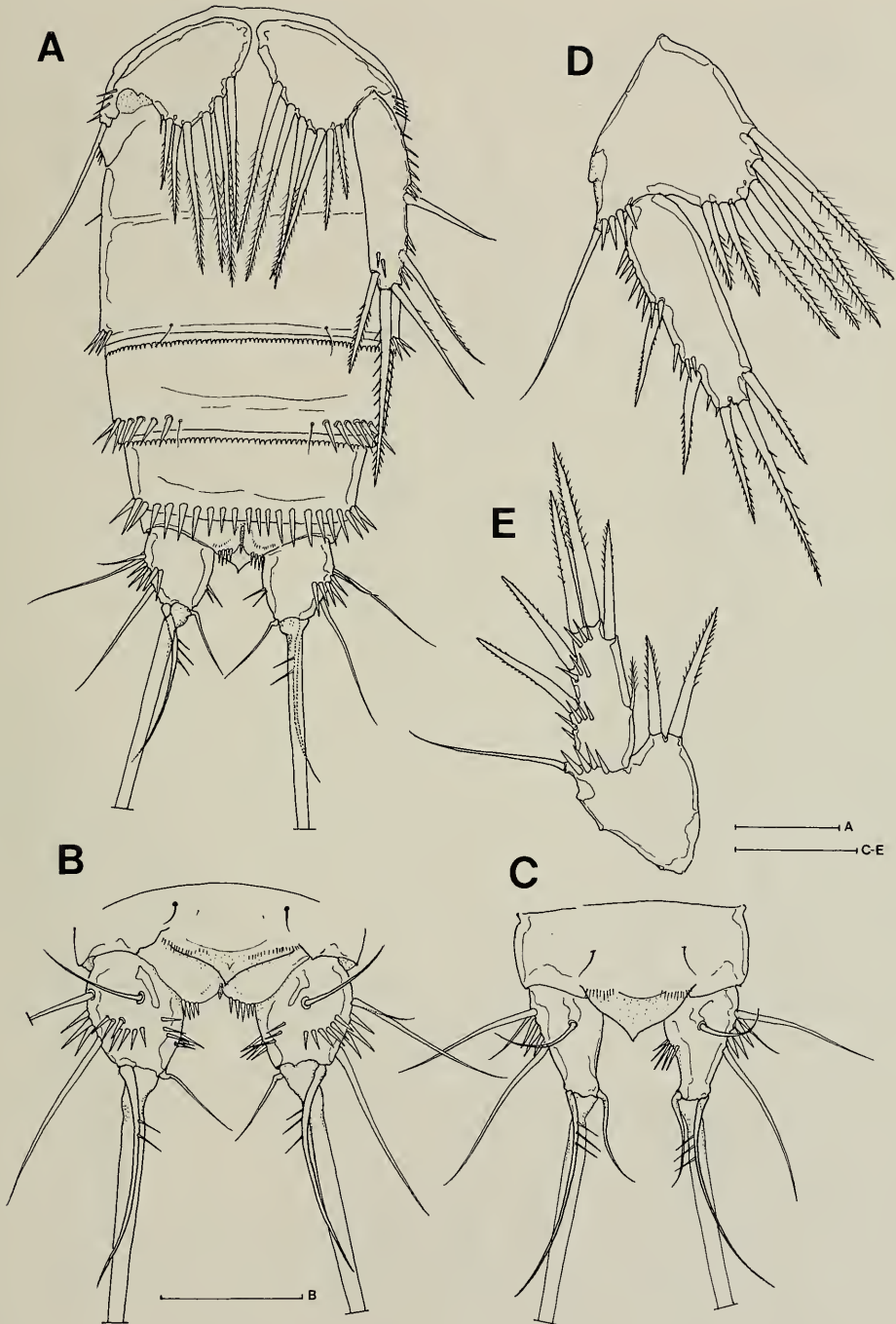


Fig. 5. *Canthocamptus incurvisetosus*. A, Urosome of female (Fn type, ventral); B, Anal somite and caudal ramus of female (Fn type, dorsal); C, Anal somite and caudal ramus of female (Fr type, dorsal); D, Female leg 5; E, Male leg 5. Scale bars = 0.05 mm.

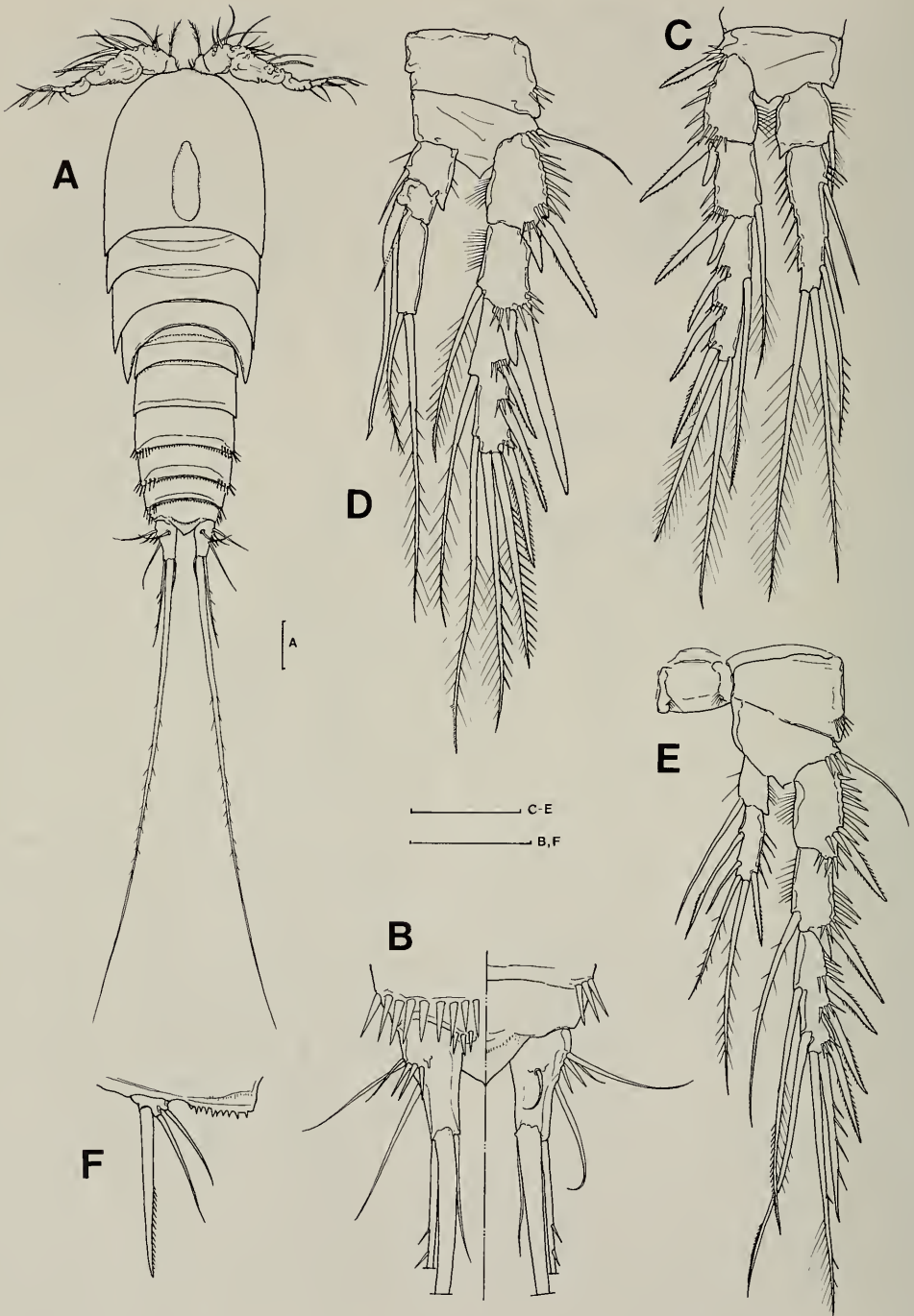


Fig. 6. *Canthocamptus incurvisetosus*, male. A, Habitus (dorsal); B, Anal somite and caudal ramus, showing both ventral (left) and dorsal (right) sides; C-E, legs 2-4; F, leg 6. Scale bars = 0.05 mm.

exceeded the tip of leg 3 exp 3. Only 28% of specimens examined had 2–3 spinules on the inner distal edge of the ventral surface of the female leg 5 exopod.

All individuals examined had the typical shape of twisted and inward-curved outer terminal caudal setae as described and illustrated above, with 2–3 secondary spinules, or exceptionally with 4 spinules. The outer terminal seta on male leg 4 exp 3 was also consistently furnished with 3–4 sharp strong spinules on its outer margin. No particular difference was detected in the major ornamentation of legs 2–4.

Etymology.—The proposed specific name is taken from the Latin *incurvus* (bent inward) and *setosus* (bearing seta), which alludes to the possession of the twisted and inward-curved outer terminal seta of the female caudal ramus, the distinctive characteristic of this species.

Remarks.—In having the apomorphic character-combination of the triangular hyaline membrane on the anal operculum and the male-type caudal ramus of the female, both these new species differ from *C. semicirculus* Kikuchi, *C. tomikoeae* Ishida, *C. mirabilis* Štěrba, and an undescribed species from Korea. They share these derived states with *C. morimotoi* Miura, *C. resupinatus* Ishida and *C. prominulus* Kikuchi. The affinities among the former group of four species will be discussed elsewhere, when *C. mirabilis* Štěrba is redescribed on the basis of the newly collected material from type locality near Beijing, China, together with the description of another new Korean species.

Canthocamptus odaeensis n. sp. shares with *C. morimotoi* a well-developed triangular hyaline membrane on the anal operculum and the normal ornamentation of the outer distal seta of male leg 4 exopod 3 (i.e., not modified with 3–4 sharp and strong secondary spinules on outer margin, but armed with about 18 or more spinules on outer margin). However, females of *C. odaeensis* may express one of two different kinds of caudal ramus, the normal-type fe-

male caudal ramus has a spinule row near the distolateral corner of dorsal surface, and the male caudal ramus has medial spinules. Females of *C. morimotoi* express only one kind of caudal ramus, which lacks the spinule row near the distolateral corner of dorsal surface, and the male caudal ramus has smooth medial face without medial spinules. However, it is distinct in showing Fr while the caudal ramus of both sexes are subconical in *C. morimotoi*. In possessing the terminal seta of leg 5 slightly longer than leg 5 exopod and the medial spinules on the caudal ramus of the male, *C. odaeensis* is similar to *C. resupinatus*, but is distinguished from that species by the normal outer distal seta on the male leg 4 exopod 3, and the shape of the outer terminal caudal seta.

Canthocamptus odaeensis resembles *C. prominulus* Kikuchi in having a relatively short spiniform process on the outer distal edge of the male leg 3 exopod 2, but the former species differs from the latter in having an unmodified terminal seta on the male leg 4 exopod 3, and in possessing the terminal seta on female leg 5 exopod slightly longer than the exopod. *Canthocamptus odaeensis* is also distinguished from *C. incurvisetosus* by the shape of the outer terminal caudal seta, the presence of a setule array on the medial surface of male caudal ramus, and the relative length of the female leg 5 exopod with its terminal seta.

Canthocamptus incurvisetosus closely resembles *C. resupinatus* in the hyaline membrane of the anal operculum and in the ornamentation of the outer distal seta of the last exopodal segment of the male leg 4, together with the twisted and inward-curved outer caudal setae. It differs from *C. resupinatus* in having the male caudal ramus with a smooth medial surface and the female caudal ramus with several spinules near distolateral corner of dorsal surface, as well as in having the terminal seta on the exopod of the female leg 5 shorter than the ramus itself. The inward curvature of the outer terminal caudal setae of *C. incurvi-*

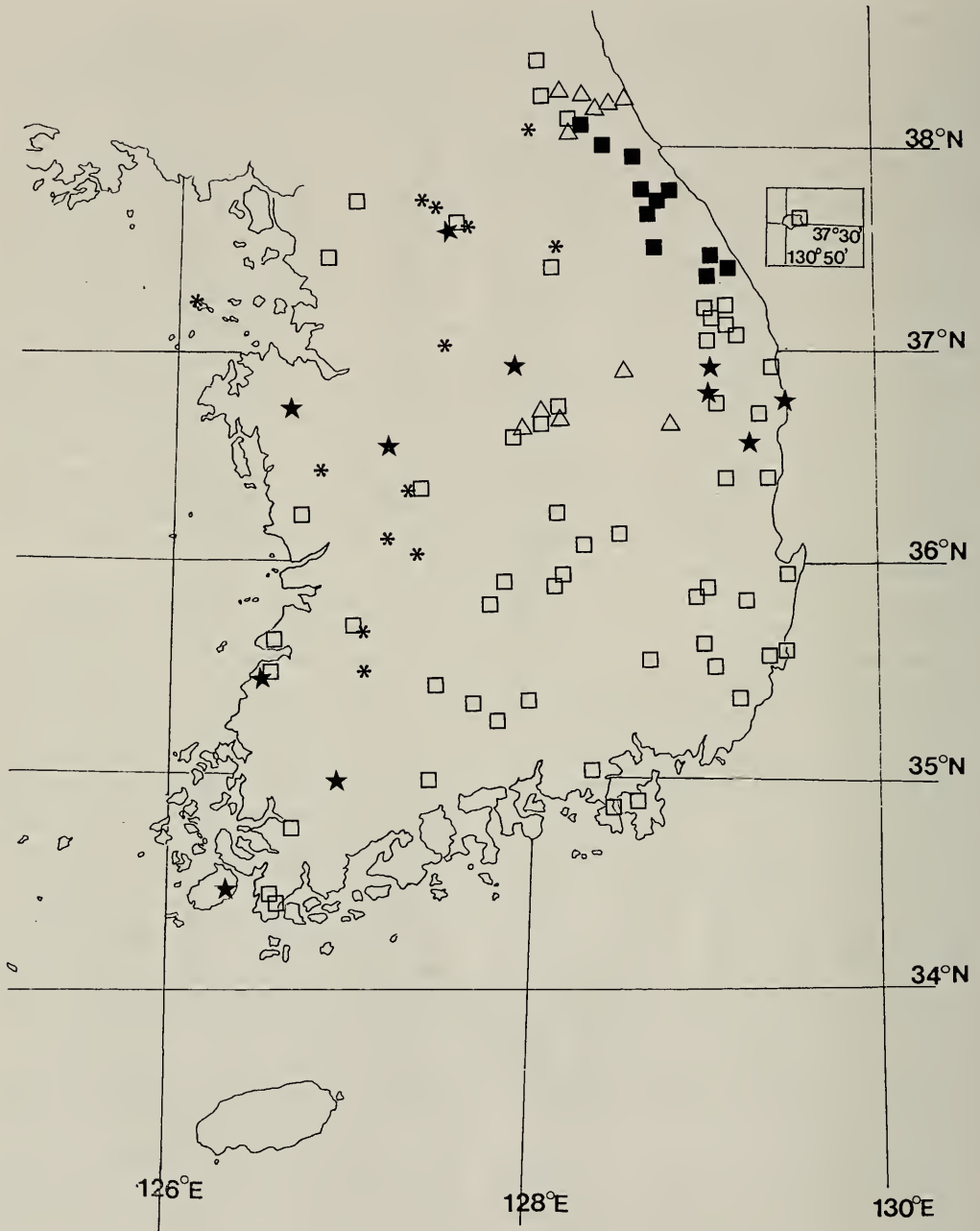


Fig. 7. Occurrence of species of the *Canthocamptus mirabilis* group in South Korea. Symbols as follows: ■ *Canthocamptus odaensis*, ★ *Canthocamptus semicirculus*, □ *Canthocamptus incurvisetosus*, * *Canthocamptus* sp., △ *Canthocamptus morimotoi*.

setosus and *C. resupinatus* is the decisive feature distinguishing these two species from other congeners. These setae are the site of initial male mechanical contact with

the female during mating of the *C. mirabilis* group. The male always grasps the proximal portion of female's caudal setae (cf. Chang 2001, Fig. 4A, B). The ornamenta-

tion of the setae is somewhat different among the members of the species group, as indicated in the specific names, the inward curvature of the outer terminal caudal setae of *C. incurvisetosus* and *C. resupinatus*. However, morphological details of these setae differ between the two species: smoothly curved with 2–3 secondary spinules on the medial surface of the seta of *C. incurvisetosus*, and somewhat sharply bent like a sickle with 7 setiform spinules of *C. resupinatus*.

Four of five species occurring in South Korea are endemic, and only *C. semicirculus* Kikuchi is known to be widely distributed in Japan (below 37°N) and Taiwan (Kikuchi & Ishida 1994). *Canthocamptus incurvisetosus* n. sp. frequently occurs in mountain waters such as streamlets, trickles, and springs in South Korea (Fig. 7). It was collected from 63 of the 120 localities studied, and ranged throughout South Korea except where *C. odaeensis* was found. Thus it co-occurred with *C. morimotoi* over the area from Mt. Sorak (northeastern South Korea) to Mt. Joryeong (central South Korea), with *C. semicirculus* along the Sobaek Mountains (which run diagonally southwestward), and with an unrecorded species of the *mirabilis* group in western South Korea. Like *C. resupinatus* in Japan, *C. odaeensis* is geographically restricted. It is found within narrow limits from south of Mt. Sorak, the northern limit of its range, to north of Mt. Taebaek, the southern limit (from 37°15' to 38°10' N), along the eastern slope of the Taebaek Mountains. This species co-occurred with *C. incurvisetosus* and *C. morimotoi* at only one location, Hangeoryong of Mt. Sorak at the northern border of its range. There, all female *C. odaeensis* were Fn type while all *C. incurvisetosus* were Fr type, and *C. incurvisetosus* possessed the elongated female leg 5 exopod bearing one seta on the medial edge as in the male, as well as several fine setules as in *C. semicirculus*. This suggests that reproductive isolation among these species where they co-occur is reinforced by

character displacement, especially of the female caudal ramus and the ornamentation of the leg 5 exopod.

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